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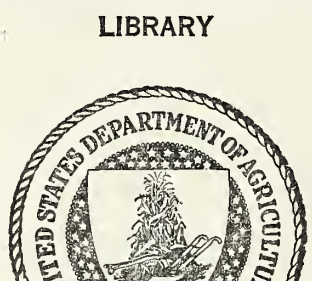

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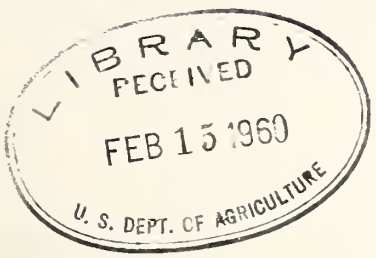
A 50-YEAR LOOK AHEAD AT

U. S. AGRICULTURE



UNITED STATES DEPARTMENT OF AGRICULTURE
Washington, D. C.
June 1959

FOREWORD

It may seem strange to some persons that the Department of Agriculture should concern itself with this long-range look at the future while it is struggling with problems of overproduction and surplus disposal. But it is a responsibility of Government to look to the long-run welfare of the Nation. As we have become more intimately acquainted with the economic problems of many countries, we have come to appreciate that our own economic strength rests on our abundant and highly developed natural resources. The land and water resources used by agriculture are among the most important of these resources.

Long-range projections are based on assumed relationships in the future and can give us only rough approximations of changes in land and water requirements that may be expected. However, the direction of change is clear. Land and water requirements for agricultural production, urban residences, industry, highways, and recreation will increase substantially. Prospects are that advances in technology of land and water use will keep pace with population growth. The improvement and application of technology and the more intensive use of our land and water resources will require increased research efforts and acceleration of programs for conservation, development, and management of our land and water resources.

E. L. Peterson
Assistant Secretary of Agriculture

935637

This report was prepared by staff members of the Farm Economics Research Division of the Agricultural Research Service, and the Agricultural Economics Division of the Agricultural Marketing Service, with assistance, collaboration, and review by scientists in other Divisions of the Agricultural Research Service, Foreign Agricultural Service, Forest Service, and the Soil Conservation Service.

Contents

A 50-YEAR LOOK AHEAD AT U. S. AGRICULTURE

INTRODUCTION

In this analysis, the United States Department of Agriculture has estimated the probable requirements for agricultural products in 2010, the yields that might be expected by that time, the acreage of land that would be required, and the acreage of land that may be available for use. The analysis is based on specified assumptions relating to population, economic growth, technology, and trends in per capita use of farm products. Within the limitations of the conditions assumed, these projections give a rough indication of longer run expansion under three levels of population, two levels of crop yields and two estimates of exports.

Production from 1934 to 1958 was ahead of needs. But this situation is not assumed to continue throughout the 50-year period to 2010, and production will have to be increased ultimately. Fortunately, there are several ways in which production of food and fiber can be expanded as our population grows and requirements for farm products increase. Continued research directed toward increased output per acre and per animal is one way. We have some backlog of known research results that can be applied for this purpose whenever it proves profitable to do so. But continued large increases in production per acre and per animal during the half-century ahead will require a vigorous program of both basic and applied research, if consumers are to continue to get a plentiful supply of relatively cheap food.

The crop yields that may be achieved in the future depend on the development of new technology and the extent to which available technology is adopted. Consequently, requirements for cropland are presented under two levels of yields: (1) Economic attainable yields; and (2) economic maximum yields. Two different levels of exports are considered also: (1) An export level of farm products approximately the same as that of 1956; and (2) an appreciably higher export level reflecting the potential needs of increasing foreign populations for our products, assuming that current impediments to movement overseas, financial and otherwise, are eliminated. Accordingly, the estimates of cropland acreages required are shown in appropriate sections of this report at two levels of exports, as well as with two levels of crop yields.

It is possible that discoveries in nutrition will indicate new technologies in utilization of food and changes in diets that will reduce our total food requirements. There is also the possibility of reducing losses in both production and marketing of farm products.

Another way by which output could be increased to meet the needs of a much larger population would be development of new land. Studies made in the Department indicate that fairly large areas of land now in pasture or in poorly stocked and nonstocked commercial forest land are suitable for cultivation and could be converted readily to productive cropland. These acreages would be in addition to the acreages to be added through

drainage and irrigation. But we need to be aware of our growing needs for timber as well as those for food and feed crops. Demand for timber a half-century ahead is likely to be about twice the present demand. 1/ In view of this, further significant withdrawals of commercial forest land for other uses should be made with the realization that such withdrawals may affect adversely our future timber supplies.

As we look ahead over as long a span as 50 years, we should keep in mind the importance of proper timing of development of new land. We should take into account the relative costs of getting additional production from development of new land and from other sources. It is important that we emphasize conservation of our soil and water resources and continue to have a vigorous program that will supply information as to the most economical ways of increasing output as the need arises.

THE ASSUMED FRAMEWORK

Prospective growth of population and of economic activity is a major consideration in any appraisal of requirements for farm products and resources needed in agriculture. This analysis is based on a population projection of some 370 million people by 2010 compared with 168 million in 1956 (table 1). 2/ The gain in population would occur in the nonfarm sectors of the economy.

An increase in personal incomes from around $2,000 (1957 dollars) per capita in 1956 to around $4,900 by 2010 is assumed. Under the conditions assumed, the gross output of goods and services in the economy by 2010 is projected to a level that is 5 to 6 times that of 1956. Projected requirements for agricultural products also reflect trends in popular consumption habits, nutrition, and other factors that influence trends in consumption of farm products.

Requirements for Farm Products

Domestic demand for farm products will continue to expand in the next half-century in response to population growth and rising living standards. The population projected for 2010 by the Department of Commerce is about 2.2 times as large as that of 1956. This is a key assumption in the analysis. Many things could happen in the next 50 years that could change the rate of growth in population that has existed during the last decade or two. This could make for large departures from this population projection, and in turn for departure from other estimates in this report.

1/ "Timber Resources for America's Future," Forest Resource Report No. 14, Forest Service, U. S. Dept. of Agriculture, January 1958.

2/ The population, GNP, and personal income projections for 2010 used in this report were developed by the U. S. Department of Commerce. The projections for 1975 given in table 1 are about the same as those contained in "Prospective Domestic Demands for Food and Fiber," by Rex F. Daly, Policy for Commercial Agriculture, Its Relation to Economic Growth and Stability, Joint Committee Print, 85th Congress, 1st Session, Nov. 22, 1957.

Table 1.- Population, gross national product, and income, specified years 1929-58, and preliminary projections for specified years 1965-2010

Year	Population	Total GNP (1957 dollars)	Personal income per capita (1957 dollars)
	Millions	Bil.dol.	Dollars
Actual:			
1929	121.9	196.3	1,154
1950	151.7	343.4	1,761
1955	165.3	425.5	1,970
1956	168.2	436.0	2,033
1957	171.2	440.3	2,032
1958 1/	174.1	426.6	1,976
Projections: 2/			
1965	195	570	2,300
1975	230	780	2,700
1980	248	910	2,900
2010	370	2,300	4,900

1/ Preliminary.

2/ Projections developed by U. S. Department of Commerce, Office of Business Economics, for Delaware River Service Area Study being made by the Corps of Engineers, Philadelphia District.

Analysis of the possibilities based on certain assumptions with respect to death and birth rates during the years between now and the year 2010 indicate that the U. S. population might range between 300 and 440 million. Some assumptions are involved over and beyond the death and birth rates. It is assumed that we will suffer no substantial misfortunes of war, and that weather for the United States as a whole will not change substantially. We assume further that population growth is partly a function of the state of our economy; that is, if we should find ourselves faced with depression, the rate of growth would slow down, but that under favorable economic conditions, growth will continue at a relatively high rate.

Domestic requirements.- In short, the estimates of possible population increases indicate that we will need more food, assuming that average per capita consumption of food remains constant or that a further modest improvement continues, but they indicate also the difficulties of projecting precisely how much food will be needed. What we must have are policies that will assure adequate food for the American people as our population grows, recognizing that the rate of population growth may vary materially from time to time in the years ahead.

Level of incomes, changes in consumption habits, and nutritional and medical developments, as well as the ease or difficulty of supplying the products that are in demand, will play important roles in determining the

quantities of individual foods and other farm products that will be consumed. The influence of many of these factors on per capita use of farm products is difficult to appraise over the longer run. Quantitative projections must be interpreted as subject to a range of possible values, and projected detail for some individual commodities may involve a substantial margin of error. Although it is difficult to specify changes in the patterns of consumption that are likely to occur during the next 50 years, we can look forward to a substantial expansion in demand for food as our population continues to grow.

Growing incomes and other trends of the last three or four decades point to further changes in our eating habits. Probably, these changes will continue to be toward more of the higher cost foods, such as meats, milk, and some of the fruits and vegetables that tend to upgrade the diet but add nothing to the number of pounds of food or calories consumed per capita. In the assumed economic framework for 2010, per capita use of farm products is projected to rise about a tenth - possibly more than a tenth for nonfood uses, and a little less than a tenth for food uses of farm products. This gain reflects a further rise in per capita use of meats and most other livestock products, a further rise in many fruits and vegetables, little change in per capita use of fats, and a further sizable decline in per capita use of cereals, potatoes, and other heavy carbohydrate foods. But the declines in use of these foods may moderate, especially if pressure on resources should develop or if nutritional and medical consideration should convince consumers that they eat too much fat and protein.

Domestic utilization of farm products in 2010 for a median population of 370 million is projected to a level about 2.4 times as large as in 1956 (table 2). As indicated in table 2, increases required for meat animals, poultry, and output of livestock products in general are greater than for crops as a whole. Production of feed crops is projected to rise less than livestock production; this reflects a further increase of about 17 percent in the efficiency of feed conversion by livestock.

Projected requirements for 2010 suggest that the output of livestock products will be around $2\frac{1}{4}$ times the 1956 output and that crop output will about double that of 1956. These projections provide at best a rough order of magnitude. The primary factor in these projections is the assumed rapid growth in population. A projected rise in imports of farm products, including such commodities as coffee, cocoa and tea, to nearly 2.5 times the 1956 volume reflects the increase in population and a further small gain in per capita use of imported products.

The changes in utilization from 1956 to 1957 (table 2) reflect mainly reductions in available fruits and vegetables because of sharp freezes early in 1957 and smaller production of beef and pork, particularly the latter. The sharp decline in exports was a reflection of abundant harvests abroad.

Per capita use of farm products for the longer run period were held at the projected level for 1975. As the economy grows, the influence of rising incomes on demand for food may diminish. It seems reasonable to assume that with the projected growth in consumer income for the next quarter-century,

Table 2.- Relative changes in farm product utilization and output, 1925-29 average, 1956 and 1957, and projections for a population of 370 million in 2010

(Index numbers, 1956 = 100)

Item	Average 1925-29	1956	1957	Projected 2010
Population	71	100	102	220
Consumer income per person	59	100	100	250
Domestic utilization of farm products	64	100	99	240
Food	64	100	100	235
Nonfood	68	100	94	260
Livestock products:				
Food	58	100	100	235
Meat animals	59	100	97	237
Dairy products	67	100	101	230
Poultry	39	100	108	250
Eggs	65	100	99	220
Nonfood 1/	116	100	95	195
Output 2/	63	100	99	225
Crops:				
Food 3/	77	100	100	240
Cereals and potatoes 4/	104	100	97	200
Fruits and vegetables	73	100	96	255
Nonfood, other than feed and seed 5/	65	100	93	250
Feed and seed 6/	81	100	98	200
Output 2/	75	100	100	196
Exports, total 7/	66	100	84	100
Imports, total	80	100	103	240
Output, total 2/	62	100	100	218

1/ Consists mainly of hatching eggs, feed, wool and grease, and tallow.

2/ Domestic utilization and total output exclude feed and seed when combining crops and livestock in order to avoid double counting of feed and livestock.

3/ In addition to groups shown, food crops include oil crops, sugar, coffee, tea, and cocoa.

4/ Includes feed grains, potatoes, sweetpotatoes, and dry beans and peas.

5/ Includes cotton, tobacco, and nonfood uses of grain and oil crops.

6/ An increase of 17 percent in efficiency of feed conversion by livestock was projected for the period 1956 to 2010.

7/ Exports in this table are assumed at approximately the 1956 level, or an index of 100 for this set of farm product requirement projections. Another set of projections was made with exports at a level of 152 and a total farm output level of 226 (1956 = 100).

American families probably will be eating the kinds of food they prefer. Therefore, further changes in income beyond the 1975 projected level may influence their patterns of food consumption very little.

Export requirements.- The foreign market for our farm products will depend to a large extent on United States policy as to prices and on programs designed to expand exports, as well as on growth of world population and other factors that affect the demand for farm products. On the basis of appraisals available, exports of both crops and livestock products were assumed for this study at two levels: (1) The 1956 level, or 100 (1956 = 100); and (2) a level of 152, or 52 percent higher than the 1956 level. 3/

Foreign demand for agricultural products is a complex function of many variables that are very difficult to predict. Actual exports, of course, will depend upon the extent to which the assumptions materialize.

The first estimate of foreign demand for agricultural products in 2010 at an export level of 100 (1956 = 100) is based on these general assumptions: (1) Population growth as projected at present by the United Nations; (2) no large-scale war or preparation for war; (3) economic resources relatively fully employed; (4) continuation of present policies of agricultural protection in importing countries and agricultural promotion in exporting countries; (5) export supplies from the United States to be available at competitive prices; and (6) no sales for foreign currency or under Government aid programs.

The second estimate of foreign demand for U. S. agricultural products in the year 2010 at an export level of 152 (1956 = 100) allows for (1) a continuation of world population growth at slightly below the present rate of increase based on the present world population projection of the U. N. for 2010 of 6.5 billion; (2) no major wars resulting in widespread devastation of agricultural resources or large population losses; (3) some continued improvement in real per capita income; (4) continued expansion in allocation of resources to agricultural production, about in line with population growth except in the Far East, where half of the population lives and where resources are most seriously limited; (5) a continuation of about present levels of consumption except in areas of lowest per capita income for which it is assumed that some improvement in the diet may be required to maintain stability; and (6) the development of means, financial or otherwise, to meet food and fiber needs throughout the world.

Range in total requirements.- Output requirements would vary widely over the projected population range of 300 to 440 million for the United States (page 3). A population by 2010 near the lower end of this range would probably be associated with high export levels while population around the upper limit of this range would result in a rapid increase in domestic consumption of farm products, permitting little expansion in exports. A population at the 300 million level combined with the 152 (1956 = 100) volume of exports results in an estimate of required farm

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3/ Levels of exports and projections are based on data prepared in the U. S. Foreign Agricultural Service.

output of 186. However, a population in 2010 of only 300 million probably would entail a slower rate of economic growth than in the past, so that domestic demand for farm products might be considerably less than this. A population of around 440 million, with exports at the 1956 level (100), would call for an increase in farm output to 256.

CROP YIELDS AND ACREAGE REQUIREMENTS

Crop Yields

Projections of crop yields were developed mainly through consultation with agricultural scientists of the Agricultural Research Service. In making projections for a given crop, agricultural scientists from such specific research areas as plant breeding, diseases, insects, weeds, soils, and water were consulted by agricultural economists.

Economic attainable yields, which are defined as the United States average yields that farmers could attain under assumed conditions, were first projected for 1975. The major assumptions used were: (1) Projected increases in yields based on greater use of technology presently known by research workers (a rate of adoption consistent with recent educational efforts of extension and related services); (2) 1975 price relationships consistent with a high-employment economy (or a parity index at about the 1951-53 level); (3) average weather in 1975; and (4) no major wars or depressions during the projected period. The original estimates for several of the crops were later reviewed and revised.

Economic attainable yields for 2010 were developed by assuming that the annual rate of increase in yields from 1951-53 to the projected 1975 level would continue on from 1975 to 2010. This assumes that new technology will become available and that its rate of adoption by farmers will be at least as rapid as it has been in the last few decades.

Table 3 shows the projected economic attainable yields for 1975 and for 2010 for specified crops, hay, and pasture, with base-period comparisons. For some crops, yields in 1956 and 1957 exceeded those projected as attainable by 1975. This may be explained by the favorable growing conditions in 1956-57, or by a more widespread use of known technology than was assumed in the projections of 1975 yields.

In the record production year of 1958, yields of many crops exceeded those projected as economically attainable by 1975. Although generally favorable weather prevailed in 1958, yields during the year indicate that the 1975 yield projections may be conservative estimates. With reductions in crop acreages in recent years, naturally crops have been concentrated on the best land. The quality of land available for use in 1975 with continuation of the improvements in progress should be as good or better than that in use in 1956.

Table 3.- Crop yields per harvested acre, 1951-53 average, 1956, and 1957, and potentials for 1975 and 2010

Crop	Unit	Average 1951-53	1956	1957	Economic attainable	
					1975 1/	2010
Feed grains:						
Corn, all	Bushel	38.7	45.7	47.1	57	85
Oats	do.	33.2	34.5	37.5	43	58
Barley	do.	27.5	29.1	29.2	38	54
Sorghum grain	do.	18.0	22.1	28.9	28	40
Hay, all	Ton	1.43	1.48	1.65	1.76	2.25
Oil crops:						
Soybeans for beans	Bushel	19.9	21.8	23.2	26	35
Peanuts picked and threshed	Pound	925	1,160	970	1,357	2,014
Flaxseed	Bushel	8.7	8.7	5.3	12	17
Food grains:						
Wheat, all	Bushel	17.2	20.2	21.7	24	34
Rice, rough	Cwt.	24.2	31.5	32.0	29.1	36.6
Rye	Bushel	12.4	13.0	16.3	14	16
Other food crops:						
Potatoes	Bushel	245	293	289	347	502
Beans, dry (cleaned)	Pound	1,173	1,210	1,133	1,341	1,597
Sweetpotatoes	Bushel	94	108	113	163	268
Sugar beets	Ton	15.6	16.6	17.7	23	34
Tobacco	Pound	1,281	1,597	1,486	1,422	1,637
Cotton	do.	291	409	388	495	805
Pasture:						
Cropland	Feed unit	979	2/	2/	1,204	1,519
Open permanent in farms	do.	194	2/	2/	233	286
Woodland in farms	do.	94	2/	2/	100	108
Grazing land not in farms	do.	56	2/	2/	65	77
All pasture	do.	180	2/	2/	216	264

1/ 1975 economic attainable yields for all hay, pasture, wheat, and grain sorghum are revised estimates.

2/ Not available.

Requirements for Cropland and Pasture

Cropland requirements with economic attainable yields.- The cropland requirements for 2010 for a population of 370 million shown in table 4 were calculated chiefly by using (1) projected requirements for farm products, including exports at approximately the 1956 level (1956 = 100, table 2), and (2) economic attainable yields (table 3). The harvested acreages that would be required for groups of crops and the cropland pasture equivalent and for related other uses that would be needed are given also. These projections suggest that considerably more land than is now used for these purposes would be needed for feed crops, hay, pasture, and oil crops. Part of the additional acreage needed could be made up from land used by food crops and cotton and by a reduction in acreages of crop failure and summer fallow. A net increase from 1951-53 to 2010 of about 14 million acres in harvested crops and an increase in pasture amounting to the equivalent of 58 million acres of cropland pasture would be needed. Partly offsetting this increase in acreage would be a decrease of 8 million acres of crop failure and summer fallow. The total net increase needed in cropland and cropland pasture equivalent would amount to 64 million acres.

Economic maximum crop yields.- Economic maximum yields assume full, efficient economic application of available technology under assumed economic conditions with parity prices at about the 1951-53 level. These yields assume widespread knowledge of new techniques and practices by individual farmers and available capital to finance desirable changes. Economic maximum yields for 1975 and 2010 were obtained in about the same way as the economic attainable yields.

Economic maximum yields average about 15 percent higher than the economic attainable yields. Some of the economic maximum yields projected for 2010 are as follows: Corn - 95 bushels; all hay - 2.62 tons; soybeans for beans - 39 bushels; and cotton - 926 pounds per acre. Crop yields that will be obtained in 2010 will depend to some extent upon: (1) Use of available technology, (2) amount and type of new technology developed, (3) extent of specialization by farmers in crops in which they have a comparative yield advantage, (4) State and regional acreage shifts, and (5) the United States harvested acreage of specified crops.

If economic maximum yields are assumed, the cropland and cropland pasture equivalent required to meet the needs for agricultural commodities in 2010 with an export level similar to that prevailing in 1956 would be 584 million acres. This is 85 million acres, or about one-eighth less than the requirement under economic attainable yields.

Agricultural Land under Alternative Yield and Export Levels

Cropland and cropland equivalent of pasture.- With the 1956, or 100, export level for agricultural commodities, the total cropland and cropland equivalent of pasture needed for the projected median population of 370 million people would be 669 million acres with economic attainable yields (table 5, col. 2). If economic maximum yields are reached, cropland and cropland equivalent of pasture needed to produce sufficient quantities

Table 4.- Harvested cropland and other cropland equivalent, 1951-53 average and 1956, and projected requirements for a population of 370 million in 2010

Item	1951-53 average	1956	Projected requirements, 2010 1/	Change required, 1951-53 to 2010
	Million acres	Million acres	Million acres	Million acres
Feed grains 2/	134	132	140	6
Hay, all	74	73	98	24
Oil crops 3/	20	28	30	10
Food grains 4/	70	53	50	-20
Cotton and tobacco	28	17	20	-8
Fruits, vegetables, and other crops 5/	22	23	24	2
Crop failure	14	6/	12	-2
Summer fallow	27	6/	7/21	-6
Soil-improvement crops, newly seeded crops, and idle land	20	6/	20	0
Total specified crops and related uses	409	6/	415	6
Pasture 8/	9/196	6/	254	58
Total cropland and cropland pasture equivalent 10/	605	6/	669	64

1/ Acreage requirements for 2010 are computed from the 2010 economic attainable yields, with a 17-percent increase in feeding efficiency, a population of 370 million, and the 1956 export level.

2/ All corn, oats, barley, and sorghum grain.

3/ Soybeans for beans, peanuts picked and threshed, and flaxseed.

4/ All wheat, rice, and rye.

5/ Potatoes, sweetpotatoes, dry beans, sugar beets, and all other crops.

6/ Not available.

7/ It is assumed that the reduction in acreage of small grains will result in a corresponding decrease in acreage of summer fallow. The reduction in acreage in summer fallow plus a reduction in acreage of crop failure would make more land available for pasture or other crops.

8/ Cropland pasture equivalent acres.

9/ Pasture acreage is for 1950.

10/ Cropland and cropland pasture equivalent areas are for continental United States, exclusive of Alaska.

Table 5.- Cropland and cropland equivalent of pasture required to meet needs for agricultural commodities for the projected median population of 370 million in 2010

Item (1)	With economic attainable yields 1/		With economic maximum yields 3/	
	Export level of 100 2/ (2)	Export level of 152 2/ (3)	Export level of 100 2/ (4)	Export level of 152 2/ (5)
	Mil.acres	Mil.acres	Mil.acres	Mil.acres
Cropland used chiefly for crops 4/	5/ 415	461	364	408
Cropland equivalent of all pasture 6/	254	254	220	220
Total cropland and cropland equivalent of all pasture	669	715	584	628

1/ Acreage requirements based on economic attainable yields with a 17-percent increase in livestock feeding efficiency.

2/ The approximate total exports of agricultural commodities were used in computing the index of 100 (1956 = 100).

3/ Acreage requirements based on economic maximum yields with a 17-percent increase in livestock feeding efficiency.

4/ Includes harvested cropland, crop failure, summer fallow, soil-improvement crops, newly seeded crops, and idle cropland.

5/ Taken from table 4.

6/ Cropland pasture equivalent of all pasture.

of agricultural commodities at the export level of 152 would be 628 million acres instead of 669 million acres needed to meet the lower export level under economic attainable yields (table 5, col. 5). (Two other projected cropland and cropland equivalent of pasture acreage requirements for a population of 370 million are given for comparison in columns 2 and 3, table 5.)

The range with different population projections, yield estimates, and export levels is very wide. For example, with a low population level - 300 million people by 2010 - economic attainable crop yields and an export level of 152, the cropland and cropland pasture equivalent requirement would be 593 million acres. With a high population of 440 million, economic maximum yields and an export level of 100, the acreage in cropland and cropland equivalent of pasture needed would be 688 million, or 95 million acres greater than with the low population level of 300 million, and 60 million acres more than with the median level of 370 million people.

CHANGES IN LAND USE TO MEET PROJECTED REQUIREMENTS WITH ALTERNATIVE YIELD AND EXPORT LEVELS

Cropland and Pasture Acreage Requirements for a Population of 370 Million

Table 6 summarizes major uses of land in 1950 and compares them with the projections of changes that would be needed to meet requirements of a population of 370 million (the midpoint of the population projections given): (1) With economic attainable yields and the 1956, or 100, level of exports; and (2) with economic maximum yields and a higher export level of 152 in contrast to the 1956 level of 100. (These levels of exports and estimates of crop yields were defined in preceding sections.) Very little change in acreage of cropland used for crops would be needed with either set of yield and export levels compared with the acreage so used in 1950. However, a substantial increase in cropland pasture would be necessary to meet the additional needs for forage by 2010. Because of increased requirements for living and working space by 2010, the acreage of land used for urban and industrial purposes would increase substantially.

The acreage of cropland required for the median population projection of 370 million with an export level of 100 would be 575 million acres with economic attainable yields (table 6, col. 3). The acreage of land required for pasture would be 795 million acres. About 500 to 505 million acres of pasture and grazing land would be grassland or nonforested land, and 290 million acres would be woodland and forest range. With economic attainable crop yields, there would be need to convert about 30 million acres of forest to cropland, pasture, and urban uses that would require clearing and to reserve an additional 14 million acres for parks and other special uses for which clearing would not be necessary.

With exports at the high level of 152 and economic maximum yields, the total cropland required would be 550 million acres (table 6, col. 6). Cropland used chiefly for crops would be 408 million acres; cropland used for pasture would total 142 million acres, and other pasture and grazing land would amount to 662 million acres. Possibly, the acreage of forest and woodland grazed would be lower with economic maximum yields on pasture than it would be with economic attainable yields. With economic maximum yields, little clearing of land would be required for cropland and pasture, except to permit retirement of poor land and for urban and industrial expansion and other special uses. (Two additional sets of projections of cropland and pasture acreages for a projected population of 370 million are given for comparison in table 6, cols. 4 and 5.)

Cropland and Pasture Acreage Requirements for Low and High Population Levels

Population projections as indicated on page 3 range from a low of 300 million to a high of 440 million. Possible variations in total population from the median assumption of 370 million are likely, with important effects on production and land requirements. With a population of 300 million, an

Table 6.- Land utilization in 1950 and projected requirements for 2010 with alternative yield and export levels for the median population projection of 370 million

Item (1)	Land use in 1950 (2)	With economic attainable yields: Export level of 100 1/ (3)	With economic attainable yields: Export level of 152 1/ (4)	With economic maximum yields: Export level of 100 1/ (5)	With economic maximum yields: Export level of 152 1/ (6)
	Mil. acres	Mil. acres	Mil. acres	Mil. acres	Mil. acres
Cropland used-					
Chiefly for crops 2/	409	415	461	364	408
For pasture 3/	69	160	160	142	142
Total cropland	478	4/ 575	621	506	5/ 550
Pasture and grazing land 6/	951	795	795	662	662
Special uses 7/	105	190	190	190	190
All other land 8/	370	344	298	546	502
Total 9/	1,904	1,904	1,904	1,904	1,904

1/ The approximate total exports of agricultural commodities were used in computing the index of 100 (1956 = 100).

2/ Includes all cropland used for crops or soil improvement or left idle.

3/ Cropland used for pasture is in the cropland rotation and subject to plowing and use for cultivated crops every few years.

4/ It is assumed that with an accelerated trend in conversion of permanent grassland pasture to cropland pasture to meet requirements, there will be a net addition of 70 million acres to cropland by upgrading pasture and a net addition of 27 million acres through land clearing, drainage, irrigation, flood control, and other improvements.

5/ With economic maximum yields, cropland probably would not need to be increased as much to meet a high export level of 152 as with the lower economic attainable yield level used in column 3.

6/ Includes forest and woodland grazed. Excludes cropland used only for pasture. From 1950 to 1954, it is estimated that about 50 percent, or 300 to 320 million acres, of the forest and woodland area was used to some extent for grazing.

7/ Special uses include urban and town areas, highway and railroad rights-of-way, airports, parks, wildlife refuges, national defense areas, flood-control areas, farmsteads, and farm lanes. In 1953, 26 million acres of forest and woodland were reserved for parks and other special uses. By 2010, it is calculated that these reservations will increase to 40 million acres.

- Continued

Table 6 footnotes continued:

8/ "All other land" includes forest and woodland not grazed, marshes, bare rock areas, sand dunes, deserts, and miscellaneous unaccounted-for areas. In 1953, the total forest and woodland acreage was estimated to be 648 million acres, including 26 million acres in reserved areas, such as parks, wildlife refuges, and other special-use areas. Net reductions in forest by 2010 through clearing for cropland, pasture, and special uses are calculated at 30 million acres, with additional reservations for special uses at 14 million acres, thus leaving a total forest and woodland acreage of about 578 million acres, exclusive of 40 million acres reserved for special uses. "All other land" is not a projected requirement.

9/ Approximate total land area of continental United States, excluding Alaska and Hawaii.

export level of 152 and economic attainable yields, the total acreage of cropland required would be 479 million acres, or approximately the same as in 1950. With a population of 440 million, an export level of 100 and economic maximum yields, the total acreage of cropland required would be 676 million, 41 percent, or 198 million acres, greater than in 1950.

AVAILABLE LAND AND WATER RESOURCES AND REQUIREMENTS

Land Resources in Continental United States 4/

A substantial "upgrading" of pastureland is one of the most promising means of adding to our forage production. Conversion of open permanent pasture to cropland or rotation pasture results in more intensive use of land and increases greatly the per acre yield of forage feed.

Possibly 70 million acres or more of the best soil areas that are now in permanent grassland pasture could be transferred to the cropland pasture rotation by 2010. In addition to the projected shift of grassland pasture to the cropland rotation, a net increase of 27 million acres of cropland is projected. This acreage could come from clearing and drainage of woodland and irrigation of uncultivated dry land. With economic attainable yields and a high export level of 152, probably the acreage of cropland would need to be increased substantially more than with the lower export level of 100. This would be done through improvement of additional grassland pasture and its shift to the cropland rotation, plus development of several million more acres of new cropland by clearing, drainage, irrigation, and related measures.

Evaluation of our land and water resources indicates that possibly as much as 110 million acres of our grassland and 105 million acres of woodland in continental United States exclusive of Alaska are fairly well adapted for use in the cropland rotation. These acreages could be used in

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4/ Continental United States, exclusive of Alaska.

the rotation if it were necessary and profitable to do so. Part of the grassland pasture is readily interchangeable with cropland. From 1953 to 1958, much cropland was seeded to pasture because of the crop allotment, soil bank, and conservation programs, which were designed both to protect the land resources and to maintain farm production comparable with demand. In the next few decades, as both population and demand for farm products increase, the shift back from pasture to cropland would be a ready and feasible way to meet part of the need.

In projecting future needs, cropland and plowable pastureland should not be viewed as entirely separate classes of land but as land available for cultivated crops and improved rotation pasture. Shifts between woodland and cropland are more difficult, time-consuming, and expensive than shifts between grassland pasture and cropland. In case of urgent need, however, several million acres of woodland could be cleared and improved for use as cropland and grassland pasture, but this could result in a loss in forest production.

In projecting the possible changes in acreages of cropland and pasture in Continental United States exclusive of Alaska by 2010, account was taken of past changes in land use and of land development, suitability of land, and availability of water for agriculture. The projections to 2010 were made under the assumption that the rate of land development for the country as a whole would exceed conversion to other uses by an accelerating rate after 1975, in line with the demand for greater farm production.

Alaska's Land Resources

Alaska's land resources and potential for population growth and farm production should be considered in any long-time projection for United States agriculture. Its rate of population growth since 1950 has been rapid and, under the impetus of statehood and policies to encourage trade, industry and resource development, there are signs of continued increase. As population pressure grows in the United States and economic opportunities develop in Alaska, our northern frontier will provide a land of opportunity for many people. Alaska's population on July 1, 1958, was estimated at 214,000.

It is estimated that about 3 million acres of land are physically suitable for tillage under technology presently known, although nearly all must be cleared of timber, moss and other debris, and some would require drainage. Another 5 to 8 million acres are potential rangeland. Perhaps half of this is suitable only for summer grazing and would require supplemental forages for winter feeding. In 1958, Alaska had about 20,000 acres of cleared land, of which probably 60 to 65 percent was on about 350 commercial farms and the rest was on another 200 to 300 partially developed homesteads. Present production provides about 20 percent of the food required by Alaska's 1958 population. The potential is for about 70 percent of needs until suitable soils become a limiting factor, although probably competition from other States will hold this down to about 50 percent.

Water Resources

Analysis of the water needs of the Nation 50 years hence with a projected population of 370 million people indicate that in some regions there will be too little water for all purposes for which it will be wanted. The old pattern of lavish use, with water taken for granted, will not obtain. In general, it is estimated that municipal and industrial water requirements will be in excess of present planned capacities. Per capita water use has more than doubled since 1930, and 1975 per capita water use excluding irrigation is expected to rise more than 50 percent from the present daily use of about 900 gallons per capita.

The largest withdrawal of fresh water for any purpose in the United States is for irrigation. About 123 million acre-feet of water are believed to have been applied to 34 million acres of farmland in the United States as a whole in 1955. This was about 44 percent of all water withdrawals in that year.

The five possibilities most frequently cited for increasing the supply of water for agricultural and other purposes in an area are interregional transfer of water, demineralizing saline waters, exploitation of deep-lying aquifers, modification of weather, and vegetative management for water yield. At present water from the first three of these possible sources is high-cost water. Furthermore, although it is physically possible to transfer water from distant sources, serious questions of water rights are involved. Each region appreciates the value of its water resources for its own future use. More research and testing is needed in all these fields to insure more practical ways of realizing the possible benefits.

Because of physical, as well as institutional, questions regarding the probable availability of water, only moderate or foreseeable increases in supplemental irrigation in humid areas were considered in making the projections of economic attainable yields. Realization of the potential effects of supplemental irrigation will depend on technological developments that can provide economical sources of water and economical means of transporting it, and on provision of institutional arrangements to facilitate the use of water.

Fortunately, there are several ways in which to increase farm production. Water is one way of increasing yields, along with improved seeds, better livestock, fertilizers, disease and pest control, and such land improvement measures as drainage, flood control, and land forming. Greater emphasis on research could result in more rapid discovery of new technology than in the past. Similarly, increased emphasis on educational programs could mean that in the future farmers would utilize available technology to a greater extent than they have done in the past or than has been anticipated in estimating attainable crop yields.

Over the longer run, or the 50-year period ahead, discovery of economical ways of desalting sea water and power from atomic or solar energy may provide a basis for economical use of greater quantities of water for

irrigation. Additional production may come also from greater emphasis on land forming or leveling and on drainage and flood control on present acreages. Also, our cropland, as well as our pastureland, can be "upgraded." For example, significant acreages of higher yielding feed crops, such as corn, could replace crops that provide a lower outturn of feed per acre. Similarly, increased acreages of feed grains and high-value hay and silage crops could be substituted for some of our pasture acreage in order to meet increased needs for livestock feed.

Competition in Use of Land and Water

On the whole, past agricultural uses of land and water were undertaken in the absence of other seriously competing types of demand for land and water. There were some exceptions, as in the Los Angeles basin and the Chicago, Philadelphia, New York and other large urban areas, but for most of the country, competition from other uses could not be regarded as a major factor in agricultural development. However, there are signs that the situation as to both land and water is changing.

Thus, over such a period as 50 years, as population increases still further and nonagricultural employment is expanded to provide incomes, competition between agriculture and forestry, urban, industrial and recreational development for the land and water needed to supply the increasing demands for agricultural and forest products and for other goods and services may become keener.

It is obvious that to meet these future requirements there must be planning in advance of actual needs in order to avoid difficulties from competing uses of water for municipal, industrial, and agricultural development.

Development of New Land

Absorption of cropland by urban and other uses will make it necessary to replace the acreage so absorbed by new land developed or by such means as increased yields. Although it is difficult to project accurately the development of new land, the replacement of an estimated 25 million acres of cropland that may be taken up by urban growth and other uses, plus projected net additions to the cropland area of 27 million acres, indicates that under conditions of economic attainable yields, an export level of 100, and a population of 370 million, 52 million acres of new cropland will need to be developed by 2010 (table 7).

Of the 52 million acres of new cropland, it is considered possible that 45 million acres could be developed by drainage, flood control, irrigation, clearing, and related measures in humid areas, and 7 million acres by irrigation and related measures in dryland areas. Estimates made indicate that there may be water available to irrigate as much as 15 million

Table 7.- Potential sources of additional cropland required with economic attainable crop yields, an export level of 100, and a population of 370 million by 2010

Source	Quantity
	Million acres
Additions to cropland: 1/	
Improvements and upgrading permanent grassland pasture to the cropland rotation	70
New cropland development by clearing, drainage, flood control and irrigation 2/	52
Total	122
Cropland absorbed through urban and other uses 3/	25
Net addition to cropland acreage	97

1/ With economic attainable crop yields and an export level of 100 (1956 = 100).

2/ This projection is for actual new cropland acreage developed from unimproved pasture, range, woodland and other land, and added to the cropland rotation. Improvement of dry cropland by irrigation or drainage of existing cropland that is too wet for normal crops each year is not included. It is likely that additional acreages of dry cropland will be improved for irrigation and that much wet cropland will be drained and protected from flooding, but such acreages are not included as new cropland.

3/ The projection for absorption of cropland by urban expansion and other uses represents the expected reduction in actual cropland used at the time the shift in use is made; it does not include abandoned cropland on idle tracts of land held for development near cities. Much land adjacent to eastern urban centers has ceased to be used as farmland. This land is not classified here as cropland. In addition to large acreages of idle or abandoned farmland likely to be occupied by future urban growth, considerable acreages of pasture, woodland, and other land are likely to be used for urban developments, highways, parks, and other special uses.

acres more in the dryland areas of the 17 Western States. 5/ Possibly half of this water would be used to irrigate existing dry cropland, but this would not be a net addition to the acreage of cropland. (Improvement of existing cropland by irrigation or drainage is considered a supplemental improvement; it is not included here as development of new land.)

The projected increase in total acreage of cropland by conversion of pasture, forest, and other land from 1950 to 2010, as given in table 7, also assumes replacement by pasture and forest of much of the 40 million acres of steep or otherwise poor cropland. This replacement would mean substantial exchanges between land uses in addition to those portrayed. It would not necessarily affect the totals in any agricultural land use.

With economic attainable crop yields and the low export level of 100, the new cropland requirements for a projected population of 370 million could be met within the additions indicated in table 7 by upgrading 70 million acres of pasture and developing 52 million acres of new land. With economic maximum yields, an export level of 152, and a population of 370 million, cropland requirements would be 25 million acres less than with economic attainable yields and an export level of 100 (table 6). With so great a demand for farm products and pressure on land resources, what appears to be more probable is that much of the increased demand would be met by striving for the economic maximum in crop yields rather than by maximum development of new land.

In making the projections of cropland acreages, it was assumed that both public and private policies would continue to encourage land improvement by irrigation and drainage and by conservation and other measures at least on a level with those of recent years. It was assumed also that a sufficient reserve of cropland and pasture would be maintained to afford a base for flexibility in crops and rotations to meet demands economically without the heavy expenditures required to reclaim large blocks of new land or to transfer large acreages unnecessarily between major uses.

With continued technological progress in agriculture, proper group planning of shifts in land use needed to preserve the good agricultural land, and public policies that will allow conversions between uses, there should be no insurmountable effects from absorption of land for nonagricultural uses within the next 50 years, even if our population increases to more than double its present number.

1/ "Water Resources Planning and Development in Agriculture," by Edward A. Ackerman. Paper, for Section O, American Association for the Advancement of Science, December 29, 1958. Reference also is made to: National Resources Board, Supplementary Report of the Land Planning Committee, Vol. I, Part IV, 1936; The Reclamation Program, 1953-59, Bureau of Reclamation, U. S. Dept. Interior, 1952; and "Irrigation Agriculture in the West," U. S. Dept. Agr. Misc. Pub. 670, Nov. 1948.

Summary

The need for new cropland under three probable combinations of three projected levels of population, two levels of crop yields, and two levels of exports are summarized here. (1) With a low population projection of 300 million, economic attainable yields and an export level at 152 percent of 1956, no additional cropland would be needed by 2010 over the total acreage in 1950, except for replacement of cropland absorbed by urban and similar uses, which is estimated to be about 16 million acres. (2) With a median population projection of 370 million, economic attainable yields, and the export level of 1956, 122 million acres more cropland would be needed to replace 25 million acres possibly taken up by urban and other uses, and for net additions of 97 million acres required for agricultural production. (The possible sources of this additional acreage are given in table 7.) (3) With a high population projection of 440 million, economic maximum yields and the export level of 1956, as much as 230 million acres of additional cropland possibly would be needed for agricultural production and replacement of an estimated 33 million likely to be absorbed by urban and other uses. So great an expansion in land requirements as was indicated in number 3 under the stated assumptions as to population, crop yields, and economic activity would cover all remaining land in Continental United States including Alaska now classified as suitable for cultivation. As indicated in previous sections of this report, the median set of projections or the situation under number 2 above appears to be more probable of occurrence than the high level of number 3.

At best, projections are only rough approximations of what might be expected under assumed conditions. Different sets of assumptions than the three combinations used would result in still other projections as to future land requirements. These three levels, however, illustrate the problem of fitting land and water resources to requirements. As we look back over the history of American agriculture, we see two major lessons of significance for projections of probable future agricultural land use:

(1) Agricultural output has increased as fast as and in some periods faster than the demand for agricultural commodities has grown.

(2) In agricultural production, land is only one of the productive factors. Other productive factors are becoming increasingly interchangeable with land, and to some extent this stabilizes the need for land in agriculture. Even so, it is good national policy to maintain as much freedom of choice as possible for future land use. The application of improved technology and more intensive use and management of land and water resources will necessitate many changes in our current patterns of use and control of these resources.